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scribed as situated "near Bristol" was in Pennsylvania. It seems more probable that it was located either on Burlington island or on the mainland near the site of the city of Burlington, in New Jersey.

Twenty years ago a colony of crows roosted on Newbold's island in the Delaware river, four miles north-west of Burlington island, and forty or fifty years ago another colony slept in a wood near Florence and, being disturbed, moved to another forest near Beverly which, within three years, has been deserted in turn for another site.

There is much to warrant the conclusion that the great roost described by Wilson was parent to this and many others now scattered over Burlington county, New Jersey.

(To be continued.)

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THE WINGS OF BIRDS.

BY I. LANCASTER.

WHILE engaged in ascertaining the methods employed by the soaring birds, on reaching a point where light began to break upon the obscurity, it became evident that the flight of all birds would be made comprehensible; that not only the day-long translation of frigate birds in circular paths high in the air, but the homeward passage of pigeons and the migratory flight of wild fowl, would emerge from the realm of fancy and range themselves with allied phenomena on the platform of recognized mechanical activities.

Indeed, many specimens of active wing flight have hitherto as completely baffled the best efforts of mechanical science as has soaring flight. When the weight of the bird is considered as resistance to be overcome by muscular force, flapping is incompetent to do the work required, and in spite of such effort gravity would compel motion in its own direction to the surface of the earth. The area of the two wings of a duck of four pounds weight, which is effective on the air in the down stroke is not more than two square feet. Counting one up and one down vibration as a single stroke, not more than three of these would be made in one second, and a liberal estimate would be an average of one foot of space traveled at each stroke for the entire wing surfaces. This ignores loss in the upward vibration. The effective work done on the air would therefore be equal to that of two square feet of surface moving at right angles to itself at the rate of three feet per second. Turning to Hutton's tables we find that a wind of about thirty feet per second is required to furnish a normal pressure of two pounds on a plane of one foot square, so that if the wings of the duck were supposed to be rigid, and the motion a continuous fall, uniformity would not be reached under a velocity of thirty feet per second. If this velocity be transferred to the wing vibration, stability of the body could only be secured by a rapidity of stroke ten times as great as what actually occurs. But when we add the air resistance to lateral motion of, say one hundred miles an hour, measured by air passing the bird, its muscular exertion becomes still more incompetent to effect the result, for now a portion of the energy which before was used to antagonize gravity must antagonize air resistance.

Further load is thus added to the working force, which before was hopelessly incompetent to its task. No method which is supposed to differ from the direct motion will assist in the least. It is velocity which is wanting. As there can be no shorter line between two points than a straight line, so there can be no more effective method than continuous motion, normal to the surface, with no change whatever in the character of the activities. A continuance of the maximum is the height of effectiveness. No screw motion, or wave motion, or figure-eight motion, which the wing may imitate, can produce results as good as the direct motion.

But bird flight thus conceived does not exist in nature. As a fact, gravity is not resistance but motive power. The bird is a machine doing work on air under the dominion of that force. The work done is not the sustained bird but the quantity of air disturbance which falls to an equilibrium with the surrounding atmosphere after the passage of the moving body through it. Gravity is not resisted, it is resolved. The bird is constantly moving in the direction of the normal component with a uniform velocity which develops air pressure sufficient to neutralize the component acting in the plane of the wings and the additional surface friction of the air. The direction of the fall is that of the gravity of the bird's mass, and this direction changes with the slant of the wings, being always at right angles thereto in obedience to the law of fluid pressures. The fall is always away from the plane of the wings, or the bird's horizon, so that no weight is lifted in the lateral motion, as the body is continually descending on its own vertical. This view completely transforms the aspect of atmospheric navigation, and brings order out of chaos.

I have hitherto spoken of the expansion of the compressed air in the rear of the wings producing the thrust needed for the lateral motion. This was done to avoid complicating the case. The significant thing is the resolution of gravity and consequent shifting of the vertical, and if this fact is seen the method of utilizing the pressures presents no difficulty.

I now wish to direct attention to the structure of a bird's wing. The wing of a pigeon or any of the barnyard fowls may be examined, as the peculiarities I desire to point out are found in all of the large birds. First, let us examine a feather. If we place one on the table with the lower surface upwards and pass the hand from the quill to the tip, it will seem smooth to the touch, while reverse motion meets with much roughness, which increases as the pressure of the fingers becomes greater. If a small tube be taken into the mouth and the breath blown quite slanting towards the tip, the feather will remain smooth and the air slip over it easily. In the reverse direction the blast will tend to open the ribs and increase the roughness. The feather is a little like a cat's back; a rub toward the rear is pleasant to all parties, while one the other way tends to cause motion of the animal to the front. Notice also that the tip is very thin and elastic, yielding in a graceful curve to slight pressure. The surface of the wing is composed mainly of these feathers, having their general direction across, with the tips to the rear. They are held by the integument covering the bones of the wing, which are located on the front edge, and while on the upper front side the curve is smooth and regularly rounded, beneath there is a projection downwards of the skin, which forms a ledge reaching along the humerus to the elbow and thence to the junction of the ulna and radius with the bones of the wrist, being greatest at the elbow. In the soaring birds this ledge is largely developed, projecting downwards in the frigate birds one and one-half inches at the elbow, tapering to the wrist and body. This ledge, at the front edge of the wing, seems at first view to be an obstruction to flight, as it makes considerable thickness where the surface first meets the air, but, as we shall presently see, it has an important function to perform as a member of the organized mechanism of flight. The curves in the plane of the wing need not be considered as they are not concerned with flight, and when the bird is in the act of flying they are straightened out so that the wing assumes a plane shape. The above four peculiarities we desire to note. Firstly, that the wing is practically a thin plane. Secondly, that its rear edge is very pliable and elastic. Thirdly, that its under surface is rough to motion from rear to front but smooth to motion from front to rear. Fourthly, that it is supplied with a ledge along its under surface at the front edge.

Let us now attend to a matter of simple experiment, which demonstrates bird flight as I have presented it in the pages of this magazine, and which connects the above-described construction of a wing, which is the organ of flight, with the mechanical forces which are operative upon it. A few cents' worth of material and the expenditure of a little time is required, which, coupled with a minimum of mechanical expertness, will suffice. The movements following changes made in the plane are so prompt and emphatic that there is no mistaking them.

If we take a sheet of light, strong paper, such as goes into the construction of fireworks, and stretch sixteen by forty inches of it tightly on thin strips of bamboo, so as to present a plane surface on one side, and fasten a four-ounce weight in the center beneath by threads to the four corners, we will have a miniature parachute. By putting its upper surface against the ceiling and permitting it to fall, it will descend vertically if we have it well balanced. It is obvious that the entire column of air from the ceiling to the floor is moved out of the place it occupied by the fall of the plane upon it. It is evident that the pressure of the plane against the air is greatest in the center, diminishing to the edges where it is nothing. Hence the zone of air under the plane, acted upon by it, would be pyramid-shaped with a base sixteen by forty inches, a top line twenty-four inches long and a height varying with the velocity of the fall of the plane, with the apex pointing downward, and there would be a steady flow or slipping of the compressed air along the surface in all directions from the center. This slipping would cause friction on the surface, which being alike in all directions no lateral motion would occur. If we now take some large-grained, light sawdust and mucilage, and thinly sprinkle one-half of the under surface from one of the long edges to the center, the level plane will no longer fall vertically but move towards the edge bounding the sawdusted half. If we extend the paper an inch over the edge opposite the sawdust and snip it into the bamboo so that it will curve upwards, we shall find on dropping the plane that its sideways motion will be augmented. If we paste a slip of paper to the front edge, allowing it to project one and one-half inches beneath, we shall find the sideways motion to be further increased so as to be many times that of the fall. If we take the plane to the housetop when the air is calm and allow it to drop, it will describe a curve while it is being accelerated, but on uniform motion occurring it will slant downwards very gently and move laterally from six to eight times as fast as it falls vertically. This experiment is very delicate and the motion varies greatly, depending on the weight and humidity of the air and the construction of the plane. The cause of this behavior is obvious. The air in rushing along the under side of the plane to escape, drags the rough surface with it to the front, slipping over the smooth part to the rear easily. Then as it turns the curve it expands against it, augmenting the front thrust. Where the air escaping toward the front meets the ledge, a complete stoppage occurs, and the thrust against it is quite violent. The ledge in front of the roughened half of the surface, and the rear curve, all tend to throw the plane edgeways in the same direction while it falls. The ledge by directly stopping the motion of the rushing air; the rough surface by frictional resistance, and the curve by presenting a base for the compressed air to expand against. The force required to produce these various results is put into the air by the descent of the plane upon it under the impulse of the gravity of its mass. The wing of a bird would act in the same way that the plane acts, and for the same reason. The elastic feather tips give the curve. The construction of the feather surfaces gives the smooth rear and rough front part; and the front projection of the integument covering the bones forms the ledge.

Why is it that the plane moves so much faster edgeways than it falls? Obviously because the condensed air in contact with the surface moves with far higher velocity than the fall, carrying the plane with it. The inertia of the air resists sudden motion so that the particles are compressed before they begin to move, and when motion at length occurs, it is sufficiently rapid to make up for lost time. A non-elastic fluid would not present this rapid motion on the compressing surfaces. If we increase the pendant weight and take the plane to the lantern of a lighthouse, or very high building, we shall find that its lateral motion will be greater, and every addition of weight will heighten the lateral velocity in a greater ratio than the fall. The reason is that the plane meets with small resistance to its edgeways motion, so that a slight increase of force in this direction moves it rapidly. But however great this motion may be, however closely it may approach level translation, by no means could it become horizontal as long as the plane itself was level. The entire force producing lateral motion comes from motion in the direction of gravity down the vertical, and horizontal translation would stop the fall, thus cutting off the motive power. But if we slant the plane the vertical goes over with it. Its own activity determines the direction of its vertical. It is fluid pressures we are dealing with, and what would be level translation on our horizontal is a constant fall from the bird's horizontal, and a soaring bird certainly needs no further explanation, neither does a wild duck. It is not heavy enough relatively to the size of its wings to reach a uniform velocity of fall which would produce the thrust needed in the lateral motion, and resort to flapping is compelled to aid the normal component of gravity. The wing now comes down with velocity sufficient to give the thrust required for horizontal flight. But both soaring and flapping would be impotent without the resolution of the direction of gravity.

The moment the plane is inclined it becomes necessary to counteract the component of resolved gravity acting in it, on the downward slant, and this component carries the plane with it during acceleration to the ground before uniform motion occurs. The application of external force to the plane, reversing its motion, is attended with difficulty on account of the rapidity of its movements and the inertia of the pendant weight. All the impulses must be steady, jolting motion being fatal to success. Care must be taken in carrying our experience of velocity derived from other things into this region. It is not likely that a vigorous man could move his limbs at a higher speed than thirty-five feet per second for a short time at his utmost exertion. These planes greatly exceed this velocity in the lateral motion, the soaring birds moving at times at the rate of 150 feet per second.

Motion of the planes, therefore, is best derived from their own activities. This can readily be obtained in still air by using fine shot for the weight in an oil-silk bag with a thin neck opening into another placed lower and fastened to the corners of the plane by separate strings. The neck should be made to allow two pounds of shot to flow through it in about ten seconds; as the shot reached the lower bag the plane would be slanted by drawing on the longer front and shorter rear strings.

With 150 feet fall this construction will give motion under the resolution beautifully. Nothing can exceed the graceful curvature of its movements excepting similar ones made by the soaring birds. As acceleration passes into uniformity and the total force is expended in the work on air, as the shifting balance inclines the plane transforming the vertical, ample force is on hand in the condensation to resist the downward slanting impulse. If the adjustment is correct, holding the plane on the right incline, horizontal motion will occur until it passes out of sight. More inclination will cause upward slanting direction. If the incline be so great as to throw too much of the resolved gravity into the plane for the forward thrust to cope with, speed will slacken and finally motion to the front will cease and be reversed on the downward slant backwards, and the frail machine become a wreck in an instant by violently striking the earth. I have floated these planes from the lantern of Egmont light at the entrance of Tampa bay, on the Gulf coast of Florida, when the air was so still that a handful of down, from the breast of a pelican, thrown from the top would quietly sink along the shaft to the ground.

To one who is familiar with the soaring birds, and has made a study of their habits, these floating planes present little that is interesting. They imperfectly imitate the birds and do nothing that the birds can not do better. The latter present a plane with automatic balance as well as a self-acting steering apparatus, and are so plentiful that they can be studied at any time. But the planes serve to explain the wing admirably, and after witnessing their performances with none, and either, and all of the contrivances for producing forward thrust, but little more need be said or done explanatory of their functions.

From the fore-leg of a reptile to this wing is doubtless a long step. It must needs be. The reptile passes life in the midst of solid, non-elastic resistances; the bird lives a divided life, part of which is under the dominion of other laws. It copes with fluid elastic pressures when it navigates the air, and nature has transformed the creature to meet the changed conditions of its existence. One pair of legs is retained to treat with forces under the dominion of laws which operate in the reptile world in common with man's world, where the sea is level, and vertical forces point to the center of the earth; where motions are deliberate, impediments plenty, clashing activities found on all sides and the area of translation confined to two dimensions only. The other pair are changed to suit a very different world where the sea is a hillside, vertical lines variable, the plane of the horizon perpetually changing, impediments non-existing, velocities high and the third dimension added to the area of translation.

With the organ of flight understood, and the resolving power of planes working on air under the law of fluid pressure comprehended, there would seem to be no further impediment to the application of the axioms of mechanical science to the problem of air navigation.

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EDITORS' TABLE.

EDITORS: A. S. PACKARD AND E. D. COPE.

—— Professor Woodrow has been finally condemned by the verdict of the highest tribunal of the denomination (Presbyterian) to which he belongs. This may cause considerable inconvenience to the professor, but we believe that it will do greater harm to the body which thus commits itself to a position which is antagonistic to the best light of to-day. It sows a seed which must produce unnecessary discord in a useful body of men, and which will interfere with its power for good, unless rescinded or disavowed. The fact of evolution is too well ascertained to permit such "bulls against the comet" to influence the thought of the day, but they make the way of truth more difficult than it ought to be.

The Rev. Dr. Deems it seems has been looking into the subject of evolution, and writes a book the conclusion of which is, that that doctrine is "not proven." Some things asserted by some evolutionists are certainly not proven, and some of these